CXII. THE ABSORPTION SPECTRA OF SOME AMINO ACIDS.

THE POSSIBLE RING STRUCTURE OF CYSTINE.

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THE object of this investigation was to find out whether the position of the absorption bands of amino acids bore any relation to the wave length of those ultra-violet rays which have proved most effective in the destruction of micro-organisms and for therapeutic purposes. When an organism is destroyed by the effects of radiation of any particular wave length a certain amount of work must have been done and a certain amount of energy corresponding to this work must have been utilised. The source of this energy is the rays absorbed by the tissues. In view of the fact that amino acids are the elements from which the protein compounds are built up and the fact that protein constitutes a large part of the non-aqueous part of protoplasm it would appear that there is a direct relationship between the absorption spectra of the amino acids and the effect of radiation on organised living matter.

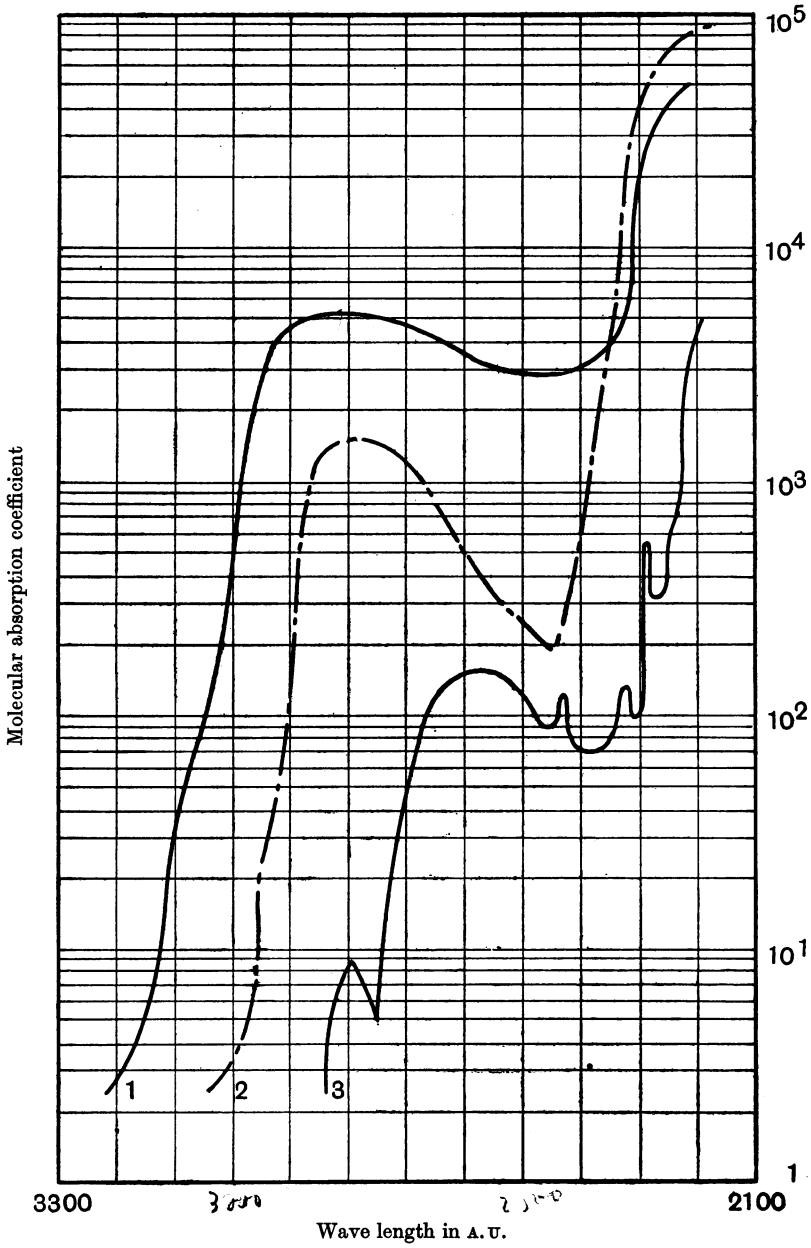
EXPERIMENTAL.

Method and Apparatus.

The method and apparatus employed in the study of the absorption spectra of these amino acids is the same as that employed by the present worker in the study of the absorption spectra of some indole compounds [Ward, 1923].

The absorption spectra of seven amino acids were measured. These were tryptophan, tyrosine, phenylalanine, alanine, histidine, glutamic acid and cystine. Of these seven amino acids, six were prepared in the Cambridge Biochemical laboratory. The remaining one, alanine, was purchased from British Drug Houses.

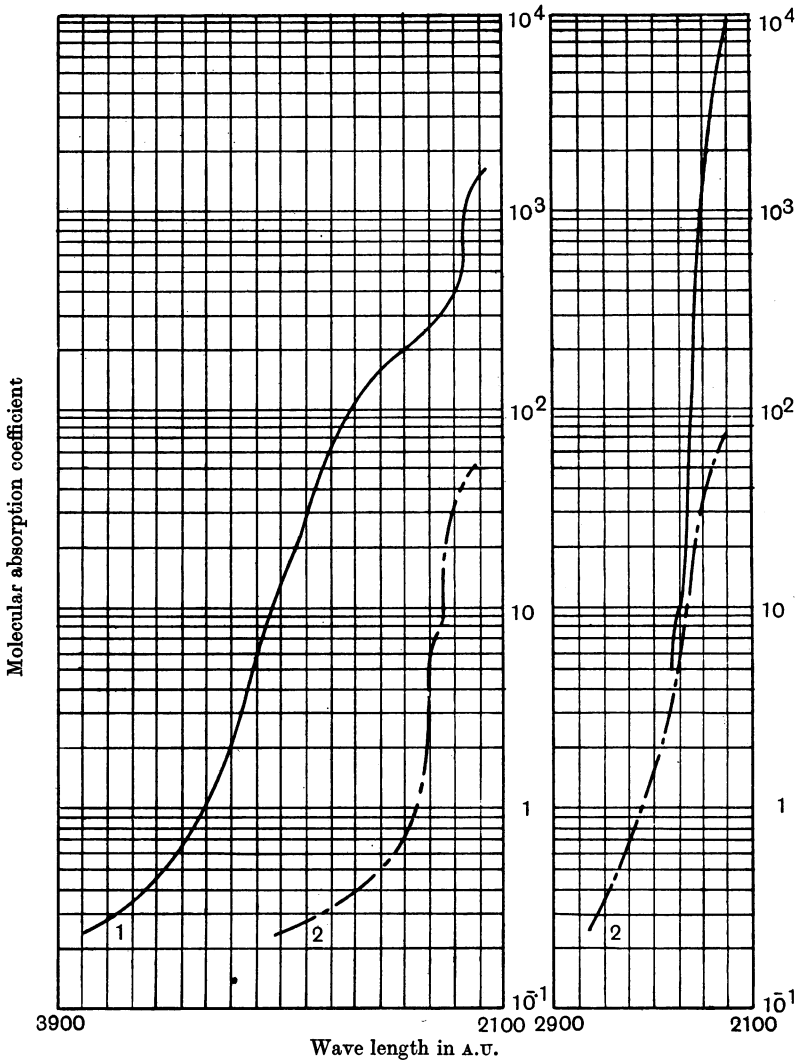
In making the absorption spectra measurements, solutions of a definite molecular concentration were used in order to obtain results that would have some basis of comparison. The solvent used for dissolving the amino acids was 50 % alcohol. Phenylalanine, tyrosine, histidine, glutamic acid and cystine were used in the form of the hydrochloride. Tryptophan and alanine were used in the form of the free acid. $M/100$ solutions of tryptophan, phenylalanine, tyrosine, and histidine were used as the strongest concentration and dilutions made from these solutions. Alanine and glutamic acid were used in $M/10$ concentration. Cystine was used in $M/20$ molar concentration and treated as if it were $M/10$ in plotting the results in order to obtain comparable results.



(1) Tryptophan. (2) Tyrosine hydrochloride. (3) Phenylalanine hydrochloride.

Fig. 1

The absorption spectra curves are plotted on Figs. 1 and 2. Fig. 1 gives the absorption spectra curves of tryptophan, tyrosine and phenylalanine, Fig. 2 *b* those of histidine and glutamic acid and Fig. 2 *a* those of cystine and alanine.



(*a*) (1) Cystine hydrochloride. (2) Alanine.

(*b*) (1) Histidine hydrochloride. (2) Glutamic hydrochloride.

Fig. 2.

Discussion.

Of the seven amino acids examined, the three acids containing the benzene ring—phenylalanine, tyrosine and tryptophan—give marked absorption bands. The others give only general absorption. Cystine gives a general absorption

with an intensity as great as that given by phenylalanine in low concentrations, and in high concentrations the absorption band extends to the edge of the visible spectrum. Kober [1915] has measured the edges of the bands of a number of amino acids without determining the complete absorption curve. From these results, it appears probable that the absorption spectra of the remaining amino acids have curves similar to those of glutamic acid and alanine.

The solar light contains ultra-violet rays that extend down to the wave length of about 3000 A.U. Cystine is the only amino acid apparently that has any marked absorption in the region of the solar ultra-violet light. It would appear suggestive that the presence of cystine in hair and wool where the concentration approaches that of about 10 %, is of physiological importance in the protection of the organism against the harmful effects of prolonged exposure to sunlight. The curious custom of the Arabs in wearing heavy but loosely fitting woollen clothing has apparently a strong justification in the protective effect of the cystine present in the wool.

Cystine appears to be present in high concentration only in the scleroproteins of hair and wool. Its concentration in the other classes of proteins is low and the absorption of ultra-violet rays would be of the same order as that caused by phenylalanine.

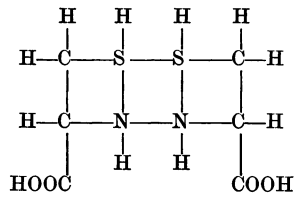
Only the ultra-violet light of the shorter wave lengths has great therapeutic value [Newcomer, 1917]. By shorter wave length is meant the rays of 2800 A.U. and shorter. These wave lengths have, however, very low penetrative power owing probably to the absorption by the outer tissues. The high absorption power of tryptophan, tyrosine and phenylalanine for the rays in the region of 2800 and 2900 A.U. throws some light on the effectiveness of these short wave lengths. These amino acids in low concentration have a high power of absorption and bring about a very complete absorption of these wave lengths. Consequently much energy is available for bringing about changes in the cell. If the amount of energy is so great that the chemical changes upset the normal metabolism of the cell, then the organism is destroyed.

The possible ring structure of cystine.

Cystine is soluble in strong mineral acids such as hydrochloric acid. It is insoluble in weak organic acids such as acetic acid. This is also characteristic of certain ring compounds containing an amino nitrogen as for example indole compounds. It is possible to make chloroacetyl derivatives of cystine by means of chloroacetyl chloride [Fisher and Suzuki, 1904], but apparently it is not possible to make acetyl derivatives of cystine by the use of acetyl chloride. Chloroacetic acid is a much stronger acid than acetic acid, being comparable in strength to hydrochloric acid.

The absorption of cystine is of a greater intensity than that of the aliphatic amino acids alanine and glutamic acid and is as strong as that of phenylalanine.

A possible explanation of these facts is that cystine does not possess the ordinary aliphatic structure usually assigned to it but that it possesses a ring structure, possibly of the following type:



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